Space Weather Technical Forecast

Issued on Thursday, 14 December 2023 at 00:37 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Isolated M-flares likely. Chance of Active-G1 Minor Storm intervals day 3 (16 Dec) from CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with a number of C-flares, with a LDE peaking C9.3 at 12/1315 UTC. This flare was from a region which has rotated off the west limb. There are eight numbered regions currently on the disc. The most prominent is AR3514 in the northwest, which continues to develop, with ongoing flux emergence, including a weak delta spot near its main trailer spot, a potentially unstable north-south magnetic field alignment. Flux emergence to the northeast of this spot has now been attributed to a newly numbered spot region AR3520. Ongoing growth is also occurring in AR3519 in the southeast, although this currently remains a simple region. The other regions on the disc are currently weak, simple and stable.
A faint, but broad CME was observed leaving the Sun to the northwest on SOHO imagery around 13/0100 UTC. This has been attributed to the LDE C2.9 flare of AR3514 and an associated dimming that started at 12/2215 UTC. Analysis has indicated a relatively slow Earth-directed CME is expected, currently anticipated to arrive on day 3 (16 Dec) around 0800UTC +/- 12 hours.

Solar Wind / Geomagnetic Activity: Solar winds as observed by ACE and DSCOVR at L1 were at background, below 400 km/s. Density was above average at first before easing below average to average. Total Interplanetary Magnetic Field (Bt) was weak, varying 5-7 nT with the north-south component (Bz) variable between +5 nT and -7nT, however around 13/2200UTC there was a possible transient passing L1 increasing the IMF to near 14nT with the Bz becoming negative, as low as -11nT at one point. Other solar wind parameters were not significantly impacted. Phi angle was predominantly positive (away from the Sun), with brief periods of negative (towards the Sun). Despite the transient the geomagnetic activity remained Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at background levels. GOES16 high energy (greater than 2MeV) electron flux was also background. The 24-hour fluence was below the Active threshold (1e8 integrated pfu). The observation at 14/0000UTC was 1.39e6 integrated pfu.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with M-class flares considered likely, primarily from AR3514.

Solar Wind / Geomagnetic Activity: The CME that occurred on 13 Dec from AR3514 is currently expected to arrive on day 3 (16 Dec) during the UTC morning with confidence low. Otherwise current background winds are likely to be enhanced from the arrival of the fast winds of CH79 later on day 1 and into day 2 (14-15 Dec), before easing thereafter. Winds are likely to peak elevated, at around 500-550 km/s, however confidence is currently low in both timing and peak wind strength. Mainly Quiet to Unsettled geomagnetic activity at first is forecast to become Unsettled to Active later on day 1 and into day 2 (14-15 Dec), with a slight chance of an isolated G1 Minor Storm interval, before easing later day 3 to Quiet with isolated Unsettled intervals. There is a chance of a spell of Active to G1 Minor storms on day 3 (16 Dec) from any CME arrival.

Energetic Particles / Solar Radiation: GOES16 high energy proton is expected to persist at background levels, with only a very slight chance of rising towards the S1/Minor Radiation Storm level given any significant flares from AR3514. High energy electron flux, as observed by GOES-16, is currently at background. The timing and strength of solar winds enhancement from CH79/+ is low confidence, but is currently expected to be relatively weak, occurring later on day 1 or day 2 (14-15 Dec). This will limit the extent of any increased flux through the Van Allen Belts, with observed flux rising to Moderate, perhaps briefly touching High on day 2 and into day 3 (15-16 Dec). The arrival of a CME on day 3 (16 Dec) is then likely to return flux to background.

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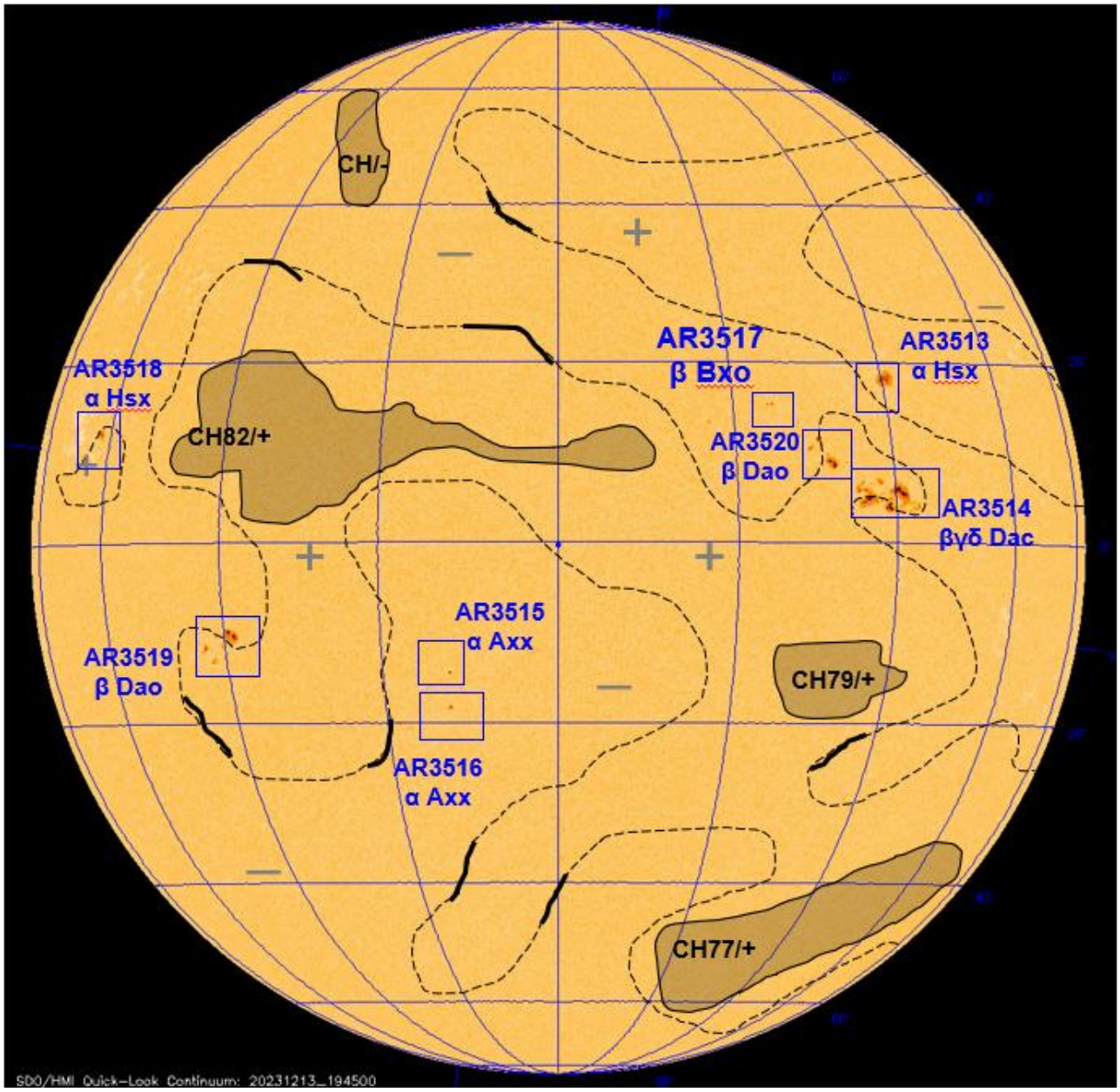
Figure 1. Solar Analysis Valid *.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME has been observed with potential for an observable impact at Earth. This was associated with a LDE C2.9 flare around from AR3514 in the northeast, and produced a faint but relatively wide partial halo with a clear coronal dimming that started around 12/2215. Analysis is still ongoing, however a preliminary assessment suggests arrival around the middle of day 4 (16 Dec).

Further weak CMEs have been observed from AR3514, including from the C9.0 flare at 12/0350 UTC. However these are either narrow, faint or very low confidence, and considered unlikely to have any noticeable impact.

Current background winds have the potential to become elevated day 1 and into day 2 (14-15 Dec) due to the onset of any fast wind from CH79/+, perhaps peaking around 500-550 km/s, Confidence is low in the timing and peak wind speeds however, due to the non-persistent nature of this coronal hole, and the MOSWOC Enlil model currently dominated by an overestimated influence from CH77/+ in the far south.

Mainly Quiet geomagnetic activity at first is forecast to become Unsettled to Active with any CH onset day 1 and into day 2 (14-15 Dec), with a slight chance of an isolated G1 Minor Storm interval, easing later day 3 to Quiet with isolated Unsettled intervals. There is a chance of a spell of Active to G1 Minor storms on day 3 (16 Dec) from any CME arrival.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	15	10	25	15
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
13/0555	Partial	Filament and C2.8 flare	AR3514	530km/s	16/0800 UTC +/- 12 hours	Low confidence

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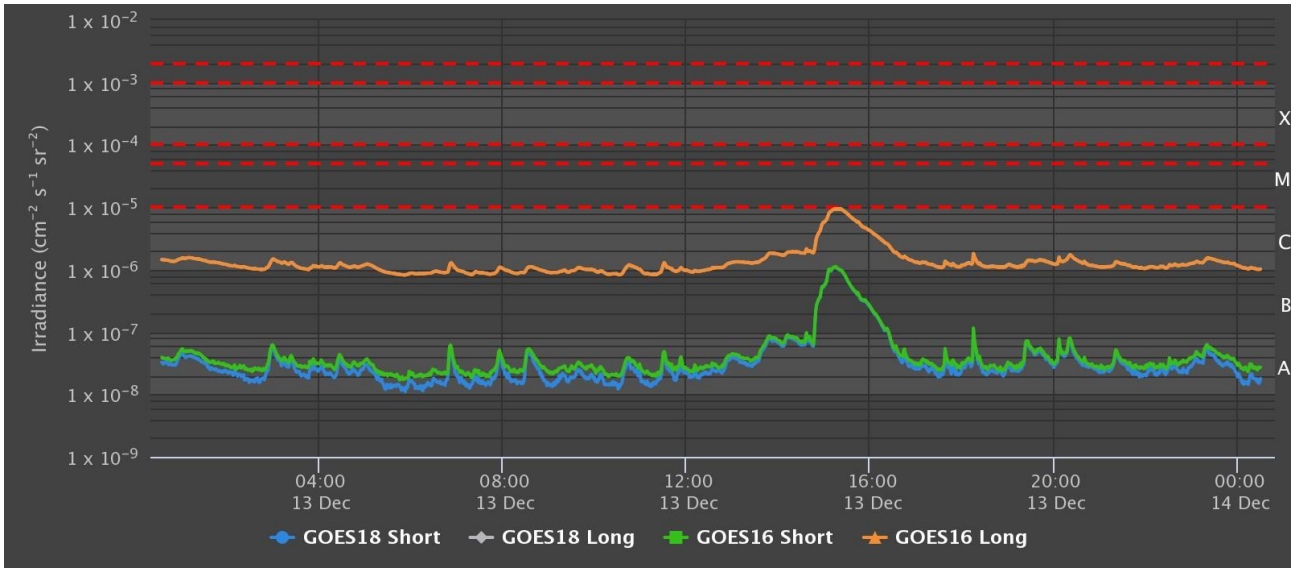
Radio Blackouts - X-Ray Flares:
Low to Moderate activity is expected, with a likelihood of isolated M-flares. There are eight numbered regions currently on the disc. The most prominent is AR3514 in the northwest, which continues to develop, with ongoing flux emergence, including a weak delta spot near its main trailer spot, a potentially unstable north-south magnetic field alignment. Flux emergence to the northeast of this spot has now been attributed to a newly numbered spot region AR3520. Ongoing growth is also occurring in AR3519 in the southeast, although this currently remains a simple region. The other regions on the disc are currently weak, simple and stable.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 2:GOES18 X-Ray flux



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at background levels. There is a slight chance of this increasing should there be any significant flares. The main risk is currently AR3514 as it develops and moves towards the northwest limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16, is currently at background. The timing and strength of solar winds enhancement from CH79/+ is low confidence, but is currently expected to be relatively weak, occurring later on day 1 or day 2 (14-15 Dec). This will limit the extent of any increased flux through the Van Allen Belts, with observed flux rising to Moderate, perhaps briefly touch High on day 2 and into day 3 (15-16 Dec). The arrival of a CME on day 3 (16 Dec) is then likely to return flux to background.
The associated 24 hour fluence is expected to remain below the Active threshold, but may rise closer to the Active threshold by the end of the period, depending on the timing and strength of the next anticipated HSS, and any subsequent CME impact on day 3 (16 Dec).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	5
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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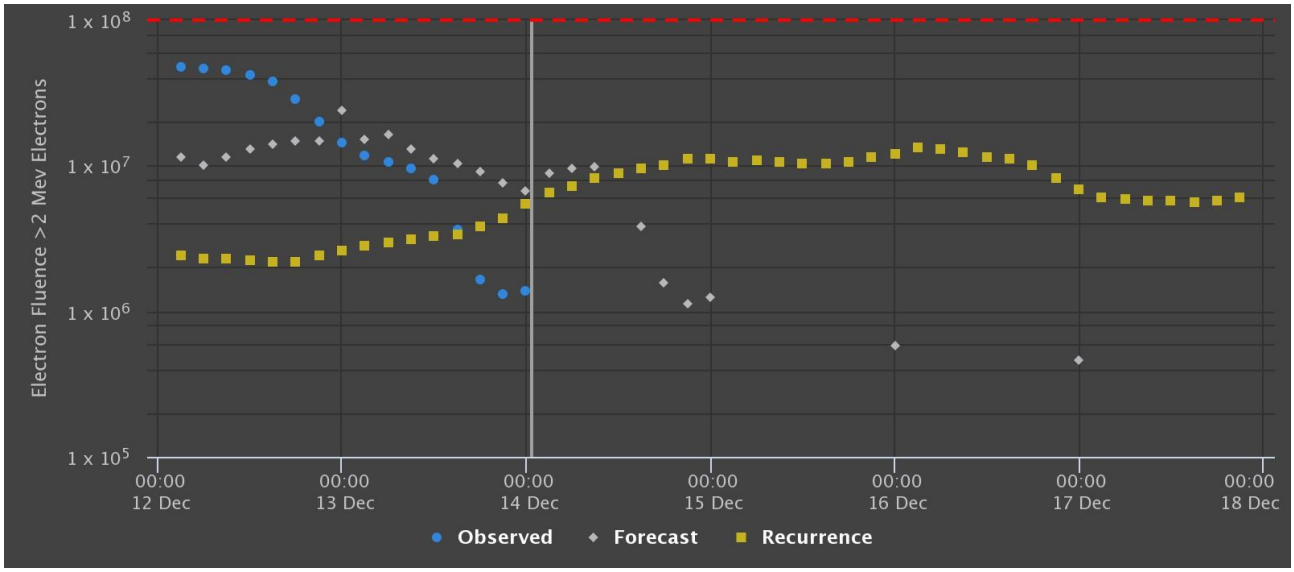
Figure 3: MOSWOC REF Model



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